Information: The Meaning of Work

"I'm going to work."
"This job is hard work."
"I worked hard to study for this test."

In general, the word "work" refers to the effort it takes to get things done. Manual labor is seen as work and so is mental labor.

Activities that may seem like work to you might NOT seem like work to a scientist. For example, if you sit quietly and study for a long time, a scientist would say that you're not doing any work at all! And you could push against a car until you were exhausted, but if the car doesn't move, the scientist would say you had done no work on the car. As you can see, there is a big difference between the everyday use and the scientific use of the word "work."

Two things must happen for a force to do work on an object. First, the **force** must push or pull on the object. Second, the object must **move a distance**. *Both must happen; otherwise, no work is done.* For example, if you pick up a book bag and put it on your desk, a scientist would say that you have done work on the book bag.

Critical Thinking Questions

1. What two things does work depend on?

2. If an object is pushed on, but does not move, is there any work being done to the object?

   Why?

Information: Calculating Work

In the scientific community, work is only done if a force is applied to an object and that object moves a distance. To calculate the work done on an object, **the force** that pushes or pulls on the object **is multiplied** by **the distance** the object moves. Work involves both force and distance.

So, how much work did you do on that book bag you lifted onto the desk? It's not hard to figure out. Multiply the force needed to lift the bag by the distance the object as lifted. That's it! In other words: Work = Force x Distance

Force is measured in Newtons (N) and distance in measured in meters (m). When multiplying the two to find Work, we end up with a Newton-meter (N*m). A Newton-meter is also called a Joule (J). Work is measured in Joules (J), for James Joule, who made important discoveries about work and energy.

Here's an example of how to calculate work:

Michael lifts his book bag, which weighs 25 N, from the floor to a desktop that is 0.80 m above the floor. How much work does Michael do on the bag?

Work = Force x Distance
Work = 25 N x 0.80 m
Work = 20.0 J

Michael does 20.0 J of work on the book bag.

Critical Thinking Questions

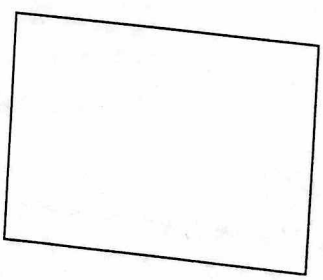
1. What units is work measured in?

2. If a pencil drops from a desk, is work being done? Why?

3. What is doing the work on the pencil from question 2?

4. What is the equation for work?

5. What would the triangle for work look like?



Put it to Use: Work Mini Lab

Problem: To investigate the scientific definition of work.

Background Information: WORK is done when a force causes an object to move in the direction of force. For work to be done, two things must occur. First, you must apply a force to an object. Second, the object must move in the same direction as the force you apply. If there is no motion, there is no work. This is very different from the way we use the word work in everyday life.

Work can be calculated with this formula:

Work = Force x Distance

$W = F \bullet d$

The units of force are Newtons and the units of distance are meters. Therefore, work is measured in Newton-Meters. These units are referred to as Joules.

Materials:

4 Books | Spring Scale | Meter Stick | 5 different objects

Part A:

1. Stand with your arms out in front of you **at waist level**, palms up.
2. Have your partner put a book on each of your hands.
3. Lift the books to about shoulder level, then lower them.
4. From waist height, lift the books over your head, and then lower the books.

Critical Thinking Questions:

1. When did you do more work: when lifting the books from waist to shoulder height or when lifting the books from waist height to over your head? Explain using what you've learned about work.

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Part B:

1. Stand with your arms out in front of you **at waist level**, palms up.
2. Have your partner put 2 books on each of your hands.
3. Lift the books to about shoulder level, then lower them.
4. From waist height, lift the books over your head, and then lower the books.

Critical Thinking Questions:

1. Are you using more force when lifting 2 books than when you were holding only one book? Explain using what you know about force and weight.

Part C:

1. Stand with your arms stretched out to the sides (like you're showing your wing span).
2. Have your partner put 2 books on each hand.
3. Hold the books at shoulder level until your arms get tired.

Critical Thinking Questions:

1. Are you exerting a force on the books?
2. Are you doing work in this situation? Explain.